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ABSTRACT

College courses that are taught without any technology are part of the past. With software that can do almost any mathematics including calculus, traditional teaching, with the instructor as all-knowing, is obsolete. In this paper, a comparison is made between business mathematics courses and general physics courses taught at a small private liberal arts college in Pennsylvania. Students in both kinds of courses realize the need for technology use in doing and interacting with mathematics. The value of knowing how to do mathematics with and without technology is fundamental to a fuller understanding of mathematical concepts. For schools that have limited budgets, small mathematics departments, or both, spreadsheets are favorable technological tools. Spreadsheets can be used for many of the mathematical concepts taught in business mathematics and general physics courses. A number of activities and learning outcomes that result from the use of spreadsheets are described. (Author)

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Some

Personal Experiences and Reflections on

Technology Use in Applied Mathematics

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Abstract

College courses that are taught without any technology use are part of the past. With software that can do almost any mathematics including calculus, traditional teaching with the instructor as all knowing is obsolete. In this paper, a comparison is made between business mathematics courses and general physics courses taught at a small private liberal arts college in Pennsylvania. Students in both kinds of courses realize the need for technology use in doing and interacting with mathematics. The value of knowing how to do mathematics with and without technology is fundamental to a fuller understanding of mathematical concepts. For schools that have limited budgets, small mathematics departments or both, spreadsheets are favorable technological tools. Spreadsheets can be used for many of the mathematics concepts taught in the business mathematics and general physics courses. A number of activities and learning outcomes that result from the use of spreadsheets are described.

Introduction

Applied mathematics courses are difficult and many students exhibit anxiety and fear when they do mathematics. Learning mathematics requires more from students than observing someone else doing mathematics. Mathematics is abstract, requires activity, and persistence for successful solutions and understanding of problems and exercises. From my experiences many students do not have the patience and the motivation to stay focused on a problem until a successful solution is reached.

The purpose of this paper is to describe some personal experiences where computers are used for applied mathematics courses such as business mathematics and physics. These courses are taught at a small private liberal arts college in Pennsylvania of about 1300 students. Mathematical modeling, interpretation of output, visualization of data, and approximation techniques are a few of the new features of these courses.

Many current publications describe the use of specific types of software, computers and calculators for learning mathematics. Some of the software described includes computer algebra systems such as MATHEMATICA, DERIVE, and MAPLE. Often these types of software provide a black box for learning where students input data and achieve results without any idea of how these results are calculated. Using spreadsheets help students develop a conceptual understanding and background for advanced mathematics learning. Spreadsheets are very valuable to learning because students can interact with this technology as they do with pencil and paper. A spreadsheet can be thought of as a piece of electronic paper where computations can be performed without any interference in learning how to use the technology. Meanings and insights are gained that are not achieved with the black box effect of many other kinds of technology. In the courses

described in this paper, the technologies used for learning and doing mathematics include primarily spreadsheets and calculators.

Personal Experiences in General Physics

The general physics course is a required course for science and mathematics majors. The course is an algebra-based laboratory course. Typical topics discussed include motion, momentum, fluids, gas laws, thermodynamics, electricity, magnetism, wave motion, optics and modern physics. Lecture, discussion, experimentation, and problem solving with technology and without technology are techniques used for presenting and learning concepts. Students taking this course are usually focused, mature, and mathematically motivated. With little instruction on how to use technology, they usually take on the new approach of using technology for learning with eagerness and success.

In my general physics course I have used spreadsheets and word processors for classroom use as well as for laboratory tools. As demonstrations in the classroom, I have shown simulations and ways to model relationships for data collected from experimentation. Students learn how to organize data, use a spreadsheet to graph data and obtain a relationship or equation to fit this data.

An example I use in physics requires students to develop a template for blood flow in the heart. The concepts taught include fluid flow, pressure, viscosity, gravity effects, and the risk factors for critical stenosis. (Dykstra & Fuller, 1988). After the template is working correctly, students are requested to input their personal values for the risk factors contributing to heart disease and from a graph of the data mark the critical stenosis point on their graph. (Critical stenosis occurs when there is a 7% reduction in actual blood flow in the heart, Dykstra & Fuller, 1988.) In another example students construct a spreadsheet model for exponential decay. The topics taught with this template include decay, prediction, estimation, and modeling relevant

situations. In particular, measuring the half-life of radioactive isotopes and of water columns is explored with this template. Obtaining an equation that measures the time it takes for a given amount of a substance, isotope or water, to be half the quantity it was when the experiment began is required from all students.

The use of spreadsheets in physics introduces students to a valuable data collection instrument. Performing calculations on a spreadsheet with close attention to the order of operations is necessary. With the use of a word processor, each lab report becomes a neat and organized document. Most students seemed to enjoy the course. Of course there were some students with little knowledge of how to use computers or calculators. The ease of use and the dynamics of a spreadsheet allowed the exploration of many concepts without interference from learning the software.

Personal Experiences in Business Mathematics

In the business mathematics course I teach, I have also incorporated technology, especially spreadsheets. Business mathematics is an algebra-based course emphasizing the use and construction of a variety of functions and their graphs. Topics taught include cost, revenue, profit, depreciation, interest, and annuities. Applications of mathematics to relevant business situations are stressed. Compared to the general physics students, most students in business mathematics are less motivated and not as prepared. They lack the mathematics expertise or maturity of the physics students. Many of them take the course only to fulfill a graduation requirement. Using a calculator or a computer enables these students to do mathematics with a focus on concepts and their meanings.

Examples of how I use technology in business mathematics include applying the order of

operations to calculating annuities, compound interest and depreciation. I also use technology in business mathematics for modeling business applications and graphing relationships for annuities, compound interest and depreciation. When annuities and compound interest for various amounts are calculated and graphed, exponential growth is clearly visualized. When depreciation for various amounts is calculated and graphed, exponential decay is visualized.

As a result of using technology for business mathematics, I have found that students enjoy the relevance of the topics discussed in the course, are more active in the course, and anticipate continued use of technology in learning and applying business mathematics ideas to other courses. Also, using the computer to do more complex problems enables students to see the value of technology as a tool for accomplishing more intuitive, accurate and confident results.

Personal Reflections and Student Comments

I have been using technology, especially spreadsheets for my courses for about 6 years. At the end of the semester I administer student evaluations for an assessment of the courses I teach. In the business mathematics and general physics courses, students expressed their enjoyment in the use of computers and calculators and they looked forward to more technology use. In comparison to other classes taken on campus, students indicated that my courses were current and innovative. They also recognized the value of using technology in preparation for their future courses and their careers.

After using technology for my general physics and business mathematics courses, I have found many similarities and differences in learning. Both classes were active in learning. Most students realized the potential of technology use and understood the value of studying relevant problems. Students also noted that the use of technlogy frees the learner from studying contrived problems or exercises that appear to always work. Many positive comments were made.

Comments from students included: "This is neat I never knew I could do this with a spreadsheet". "These graphs are interesting. Now I see what this means". "I did not know what these calculator keys meant. I never thought I would be able to use these calculator keys". An older nontradtitional student noted, "I told my boss how to use this calculator key, he was impressed".

Courses that use technology enable concepts to be studied in multiple ways. Symbolizing, visualizing and approximating ideas are part of the learning process in mathematics. Modeling relevant situations, and requiring the student to communicate results are becoming widespread. Students are often surprised when numerical results are not enough for a complete solution to a specific problem or exercise. A requirement of parts of my courses is to have students demonstrate and explain the process they go through to achieve a successful result. Verbal and quantitative communication are necessary for a complete understanding of mathematical concepts.

I have also found that software can be revised and updated as newer releases become available. For example I have used LOTUS 1-2-3 for DOS for a number of years. I easily updated my spreadsheet software to LOTUS 1-2-3 for WINDOWS. I have used the software I developed in LOTUS for DOS in LOTUS for WINDOWS. I have discovered that there is virtually no difference between these 2 spreadsheets. My transition was smooth from DOS to WINDOWS and all my previous work was not lost or wasted.

Conclusions

In the general physics course, students found that using spreadsheets helped them understand ideas more clearly. Graphing data with a computer was a much better way of presenting data than by hand on graph paper. The dynamics of a spreadsheet gave students almost instantaneous answers for questions and problems being considered. Careful analysis of output

was required. Knowing when the result was correct without performing too many calculations was also necessary.

In the business mathematics course, students appeared to rely on technology too much. Students must know when and when not to use technology. Although calculating amounts for compound interest, annuities, and amortization payments was a lot easier for students who used a spreadsheet, overuse of technology must be eliminated From my experiences in teaching business mathematics and general physics, the use of technology does help students understand and apply mathematics. Also motivation for learning appears to increase and with this increased motivation, more in-depth explorations of concepts become possible. Learning mathematics is no longer a tedious, boring, and passive endeavor but one of challenge, persistence and interaction.

References

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